

# Impact of Post-Harvest Operations on Seed Quality in Soybean

## ABSTRACT:

The influence of threshing, cleaning and processing operations on seed quality in two varieties of soybean was studied to identify the best post-harvest operation to maintain seed viability and vigour. The two varieties viz. Basara and JS 335 were subjected to five different post-harvest operations and two sieve sizes of 3.75 and 4.00 mm. The mechanical damage (%), seed recovery (%), physical purity (%), germination (%), seedling vigour Index II (SVI II), field emergence, electrical conductivity, amino acids and total soluble sugars in seed leachates of processed seed were determined. Among the two varieties Basara recorded lowest mechanical damage and higher germination and field emergence compared to JS 335. The highest seed quality with lowest mechanical damage was reported in seed threshed and cleaned manually. Electrical conductivity showed a non-significant variation in all the treatments while amino acids and total soluble sugars in seed leachates were lowest in Basara. The character association studies revealed a positive association of germination and field emergence and negative association of germination and mechanical damage, amino acids and total soluble sugars in seed leachates.

---

**Key Words:** Soybean, Mechanical damage, Germination, Electrical conductivity.

## **INTRODUCTION:**

Soybean (*Glycine max* L. Merrill) is an important oilseed crop globally and popularly grown in temperate regions, however, it is gaining popularity in India also because of ease in production with high yields. The major constraint associated with soybean production in tropics is supply of quality seed due to post-harvest losses i.e., rapid loss of vigour and germination in storage. Loss of germination is more acute in tropical countries (Pascal and Ellis, 1978) [13] as compared to temperate environment. In tropics, more than 40 % of the losses occur during post-harvest and processing operations (Gustavsson *et al.*, 2011) [7]. The post-harvest losses in soybean include field weathering and impact on seed during post-harvest operations influencing seed coat integrity and thereby resulting in damage to embryonic axis.

Manually cleaned seed retains good germination, but it is labour, intensive and time consuming, thus mechanical threshing and processing are commonly adopted. Irrespective of the extent, mechanical injuries reduce seed longevity and storability, predisposes seed to infection, reduces germination and vigour, (Navratil and Burris, 1984 [11]; Cicero *et al.*, 1998 [4]). Mechanical processing of seed will help in improving the physical purity, test weight, germination and vigour of seed, however mechanical damages during post-harvest operations were identified not only in soybean but also in green gram, black gram, sunflower (Bansal and Lahan, 2009) [3] and chickpea (Sinha *et al.*, 2009) [16]. The extent of mechanical damage varies with varieties, hence appropriate postharvest operations to attain seed of high quality with good seed recovery should be determined.

Hence there is a need to identify an appropriate feasible processing chain to reduce loss in seed quality which leads to disruption in seed multiplication chain especially during breeder and foundation stage of seed production. This information can be useful to identify the reasons associated with seed damage and intervene into new post-harvest management strategies to mitigate losses during processing.

## **MATERIAL AND METHODS:**

The two varieties of soybean (JS-335 and Basara) grown during *Kharif* 2021 at the Agricultural Research Station, Adilabad was harvested manually at harvest maturity and subjected to cleaning after drying. To study the influence of post-harvest operations on seed quality the two varieties of soybean seed were cleaned using two sieve sizes i.e., S1 3.75mm and S2 4.00 mm and five post-harvest methods viz. P1 threshed by beating with wooden sticks and hand cleaned, P2 threshed with a multi-crop thresher and hand cleaned, P3 threshed with a multi-crop thresher and cleaned in fine cleaner in Fowler Westrup make 4 TPH machine, P4 threshed with a multi-crop thresher, cleaned in fine cleaner in Fowler

Westrup make 4 TPH machine and graded in Spiral Separator through conveyance by rubberized elevators and P5 threshed with a multi-crop thresher, cleaned in fine cleaner in Fowler Westrup make 4 TPH machine and graded in Spiral Separator through conveyance by normal elevators.

The seed collected by various methods was tested for seed quality parameters at the Department of Seed Science and Technology, Seed Research and Technology Centre, PJTSAU, Hyderabad. The physical parameters i.e., percent mechanical damage was calculated by Ferric chloride method suggested by Agarwal (1995) [2], percent seed recovery was estimated as per the procedure given by Vishwanath *et al.*, (2019) [17] and physical purity as per ISTA (2019) [8]. The Seed germination and electrical conductivity was estimated as per ISTA (2019) [8], Seedling vigour index II was calculated as per the method suggested by Abdul-Baki and Anderson (1973) [1] and field emergence was determined by sowing hundred seeds in two replications.

$$\text{Field emergence \%} = \frac{\text{Number of seedlings germinated on eight day}}{\text{Total number of seeds sown}} \times 100$$

The total soluble sugars in seed leachates were estimated as per method of Dubois *et al.*, (1951) [18]. To 1 ml of seed leachate, 1 ml of 5% phenol solution is added, followed by 5 ml of concentrated H<sub>2</sub>SO<sub>4</sub> and the mixture is Shaked well, allowed to cool at room temperature and absorbance was recorded in spectrophotometer at 490 nm. The free amino acids in seed leachates is done as per ninhydrin method. To 1 ml of seed leachate, 1 ml of ninhydrin solution is added and kept in boiling water bath for 20 min followed by addition of 5 ml of diluent solvent. The intensity of the purple colour against a reagent blank is read in the calorimeter at 570 nm. The data was analysed using three-way ANOVA on Completely Randomized Block Design (CRD) as suggested by Panse and Sukathme (1978) [12].

## RESULTS AND DISCUSSION:

The varieties showed a significant variation for all the physical parameters of the seed (Table: 1) with Basara recording lowest mechanical damage and highest physical purity, while seed recovery was more in JS 335. A significant variation in seed physical parameters was observed for post-harvest treatments with lowest mechanical damage in P<sub>1</sub>, highest seed recovery in P<sub>1</sub> and physical purity in P<sub>5</sub>. A significant variation for sieve sizes was observed for seed recovery and physical purity with highest values in S1 and S2 respectively.

The physical changes in two varieties of soybean across various post-harvest operations are given in Figure. 1. The percent mechanical damage in Basara ranged from 18% (P1S1) to 32% (P5S2), while in JS 335 from 19.5% (P1S1) to 35.5% (P5S1) and

increased gradually from manual method to fine grading in both the varieties. The seed recovery was found to be significant among varieties, sieve size and post-harvest treatments and ranged from 86 (P5S2) to 94.25 (P1S1) percent in Basara and from 87 (P5S2) to 96.25 (P1S1) percent in JS335. Lowest physical purity was recorded in P1 and highest in P5 in both the varieties.

The mechanical threshing and processing operations caused significant mechanical damage in both the varieties with significantly higher damage in JS 335 compared to Basara indicating that Basara offered better resistance to mechanical operations than JS 335. These results corroborate to similar results obtained by Delouche (2021) [5], Gagare *et al.* (2014) [6] and Rodrigo Albaneze *et al.* (2018) [14] in soybean.

A significant variation was observed among varieties for all physiological parameters i.e germination, SVI II and field emergence, while post-harvest treatments showed significant variation for germination only and sieve sizes for germination and field emergence (Table.2). Basara recorded highest germination (90.05 %) and field emergence (84.70 %), while highest SVI II was observed in JS 335 (7667.85). The treatment P1 recorded highest germination of 90.25%, while P5 recorded a lowest germination of 85.88 % and among the sieves, highest germination was observed in seed cleaned using 4 mm sieve. Field emergence was more in seeds cleaned using a 4 mm sieve than in 3.75 mm sieve.

The pattern of physiological performance of two varieties of soybean at various stages of post-harvest operations is presented in Figure.2. The germination percentage in Basara ranged from 89 % (P5S2, P3S1) to 91.5 % (P1S1) and in JS 335 from 79% (P5S1) to 91% (P1S2). The SVI was highest in V2P1S2 (8443.5) and lowest in V1P5S1 (6306.5) and decreased gradually from manual to mechanical methods. A significant variation among interactions was not observed for field emergence, however it ranged from 81.5 (P2S2) to 87% (P2S1 and P5S1) in Basara and from 71.5 (P5S1) to 82.5 (P4S2) per cent. Similar highest germination and vigour was observed by Seema and Betageri (2021) [15] in seeds threshed by stick beating. Highest germination and vigour in seeds threshed and cleaned manually is due to low mechanical damage leading to less damage and high vigour. Nagawade *et al.* (2015) [10] also reported that pre-processing samples recorded higher germination and vigour index-I, followed by seeds obtained after pre-cleaner in and seeds collected at the end of the processing chain.

The biochemical parameters i.e., electrical conductivity showed a non-significant variation for all the treatments, while amino acids and total soluble sugars in seed leachates was found to be significant among varieties with Basara recording lowest values compared to JS 335. The total soluble sugars in seed leachates showed a significant variation among the post-harvest treatments with lowest values in P1 (57.89 µg/ml) and highest in P5 (99.39

$\mu\text{g/ml}$ ). The range of biochemical parameters in two varieties across post-harvest treatments and sieves is presented in Figure 3. The electrical conductivity in seed leachates ranged from 141.78 to 284.70  $\mu\text{S cm}^{-1} \text{g}^{-1}$  in Basara and from 139.37 to 228.64  $\mu\text{S cm}^{-1} \text{g}^{-1}$  in JS 335. The amino acids in seed leachates showed a non-significant variation among the treatments and ranged from 25.5  $\mu\text{g/ml}$  (V1P3S2) to 23.42  $\mu\text{g/ml}$  (V2P5S2). The total soluble sugars in seed leachates showed a gradual increase from manual to mechanical methods with lowest values in P1S2 in both Basara (54.88  $\mu\text{g/ml}$ ) and JS 335 (59.25  $\mu\text{g/ml}$ ) and highest values of 82.31 and 118.31  $\mu\text{g/ml}$  in P5S1 in Basara and JS 335 respectively.

The studies on the association of seed quality characters revealed a significant positive association of seed germination with field emergence and a negative association with mechanical damage in seeds, while both germination and field emergence showed a negative association with amino acids and total soluble sugars in seed leachates. This reveals a possible influence of mechanical damage on seed deterioration leading to release of amino acids and total soluble sugars in seed leachates. The mechanical damage of seed had a significant positive association with total soluble sugars in seed leachates and a negative association with seed recovery. A similar negative correlation of seed germination with cracked seed coat and broken seeds was observed in peas by Karagi *et al.* (2010) [9].

## **CONCLUSION:**

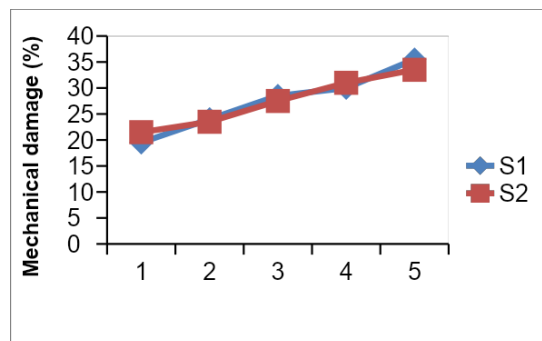
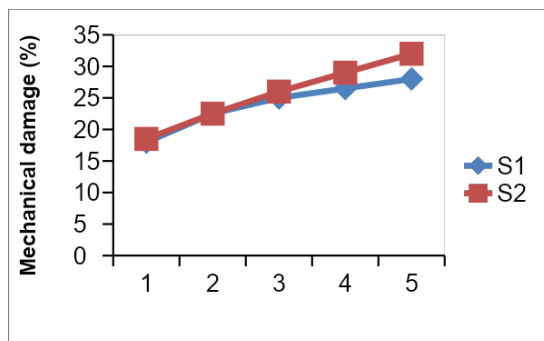
From this study, it can be concluded that, at every post-harvest operation of seed i.e., mechanical threshing, fine cleaning, grading etc., the mechanical damage has gradually increased in soybean with maximum damage in seed subjected to fine grading in spiral separator and passed to normal elevators. This damage is reflected by a decrease in seed germination, vigour and increase in electrical conductivity, amino acids and total soluble sugars in seed leachates. However marginal and non-significant variations were observed in the seed quality parameters immediately after processing, but there is a possibility for significant variations in seed quality parameters under storage as mechanical damage leads to decrease in germination, vigour and increase in EC and total soluble sugars in seed leachates which can be further hastened leading to seed deterioration.

**Table:1 The effect of post-harvest operations on the Mean physical parameters of seed after processing in Soybean**

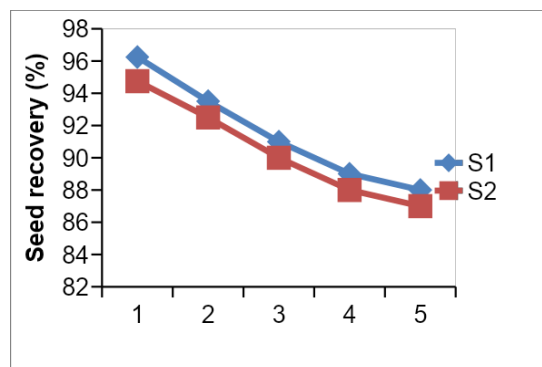
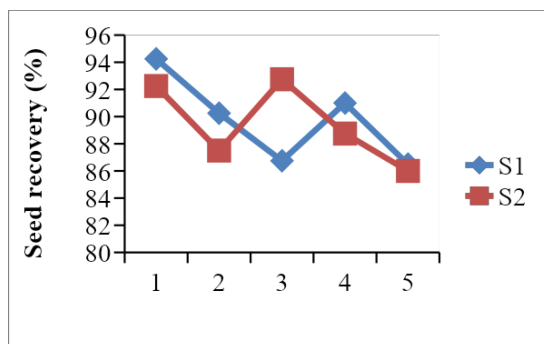
Factor	Level	Mechanical Damage (%)	Seed Recovery (%)	Physical Purity (%)
Variety	Basara (V1)	24.80	89.60	98.09
	JS 335 (V2)	27.45	91.00	98.05
Post-harvest treatments	Manual threshing and Manual cleaning (P1)	19.38	94.38	97.53
	Mechanical threshing and Manual cleaning (P2)	23.13	90.94	97.96
	Mechanical threshing and Cleaning in Fine cleaner (P3)	26.75	90.13	98.14
	Mechanical threshing and Cleaning in Fine cleaner and grading in Spiral separator (using rubberized elevators) (P4)	29.13	89.19	98.23
	Mechanical threshing and Cleaning in Fine cleaner and grading in Spiral separator (using normal elevators) (P5)	32.25	86.88	98.49
Sieve size	3.75 mm (S1)	25.75	90.65	98.06
	4.00 mm (S2)	26.50	89.95	98.08
<b>CD</b>	Variety	1.396	0.443	0.164
	Post-harvest treatments	2.207	0.7	0.259
	Sieve size	NS	0.443	0.164
	V X P	NS	0.99	0.367
	V X S	NS	NS	NS
	P X S	NS	0.99	NS
	V X S X P	NS	1.4	0.519

**Figure.1. The effect of various post-harvest operations and sieve sizes on the physical parameters in Soybean**

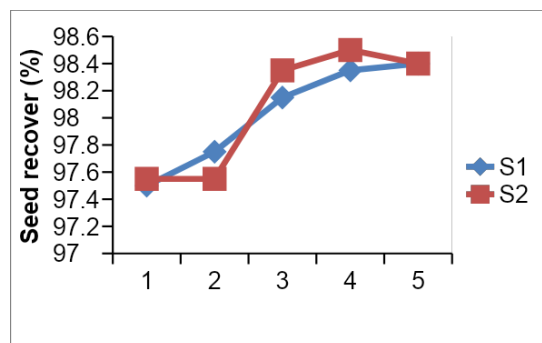
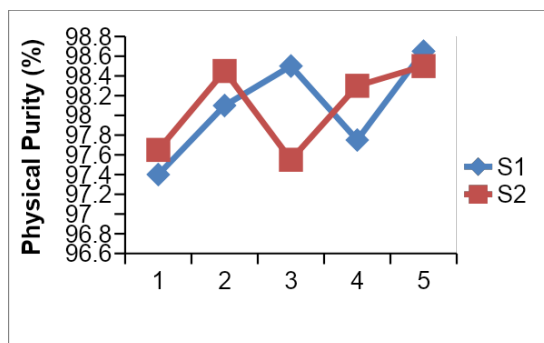
**Mechanical damage (%)**



**Seed Recovery (%)**



**Physical Purity (%)**



**Post-harvest practices**

P1: Manual threshing and cleaning

P2: Mechanical threshing and Manual Cleaning

P3: Mechanical threshing and Cleaning in fine cleaner

P4: Mechanical threshing + Cleaning in fine cleaner+ grading in spiral separator (using rubberized elevators)

**Sieve sizes**

S1: 3.75 mm

S2: 4.00 mm

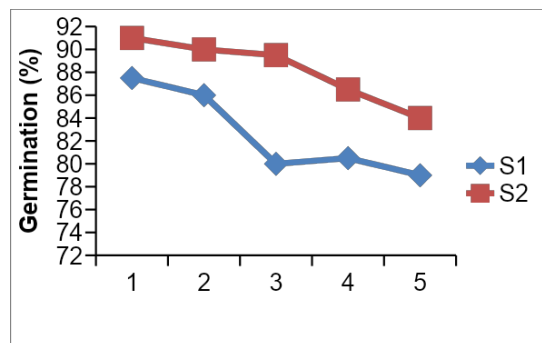
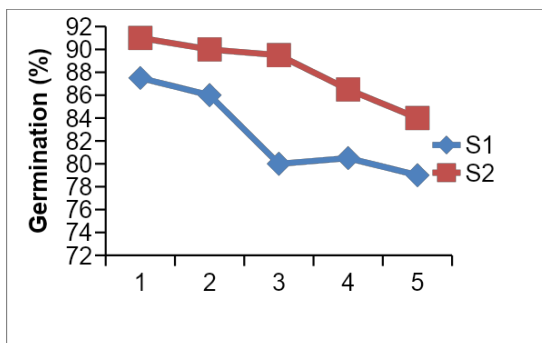
P5: Mechanical threshing + Cleaning in fine cleaner+ grading in spiral separator (using normal elevators)

**Table 2. The effect of post-harvest operations on the Mean physiological parameters of seed after processing in Soybean**

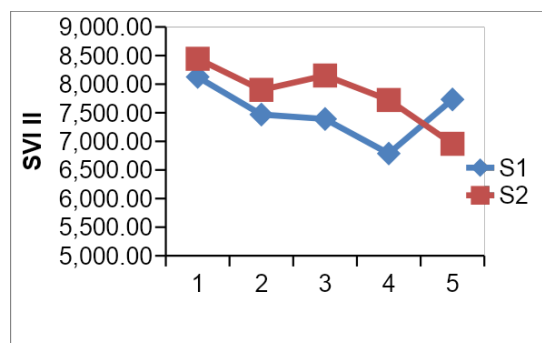
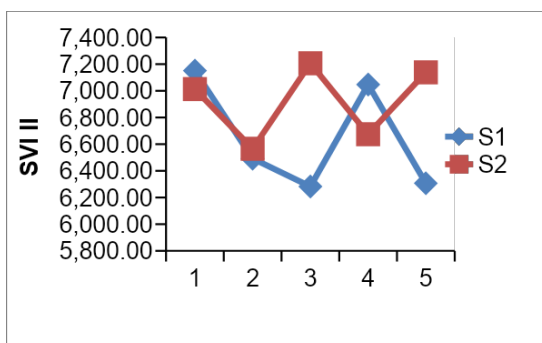
Factor	Level	Germination %	SVI II	Field Emergence (%)
Variety	Basara (V1)	90.05	6787.60	84.70
	JS 335 (V2)	85.40	7667.85	75.50
Post-harvest treatments	Manual threshing and Manual cleaning (P1)	90.25	7683.00	81.63
	Mechanical threshing and Manual cleaning (P2)	88.88	7106.50	79.63
	Mechanical threshing and Cleaning in Fine cleaner (P3)	87.25	7257.50	79.63
	Mechanical threshing and Cleaning in Fine cleaner and grading in Spiral separator (using rubberized elevators) (P4)	86.88	7057.88	80.63
	Mechanical threshing and Cleaning in Fine cleaner and grading in Spiral separator (using normal elevators) (P5)	85.38	7033.75	79.00
Sieve size	3.75 mm (S1)	86.25	7078.20	78.75
	4.00 mm (S2)	89.20	7377.25	81.45
<b>CD</b>	Variety	1.749	301.496	2.66
	Post-harvest treatments	2.765	NS	NS
	Sieve size	1.749	NS	2.66
	V X P	NS	NS	NS
	V X S	2.473	NS	3.761
	P X S	NS	NS	NS
	V X S X P	NS	NS	NS

**Figure.2. The effect of various post-harvest operations and sieve sizes on the physiological parameters in Soybean**

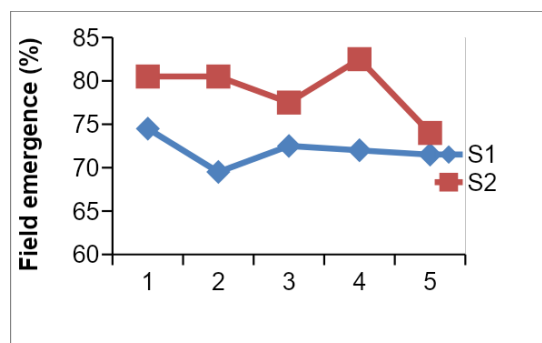
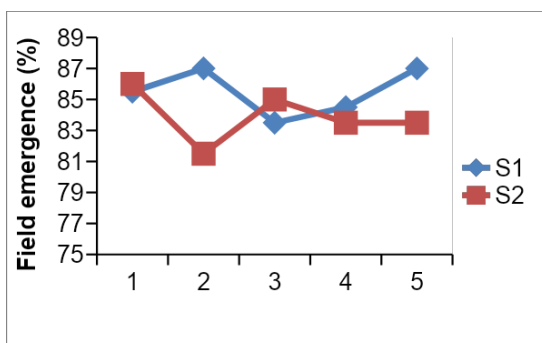
**Germination (%)**



**Seed vigour index II**



**Field Emergence (%)**



**Post-harvest practices**

P1: Manual threshing and cleaning

P2: Mechanical threshing and Manual Cleaning

P3: Mechanical threshing and Cleaning in fine cleaner

P4: Mechanical threshing + Cleaning in fine cleaner+ grading in spiral separator (using rubberized elevators)

**Sieve sizes**

S1: 3.75 mm

S2: 4.00 mm

P5: Mechanical threshing + Cleaning in fine cleaner+ grading in spiral separator (using normal elevators)

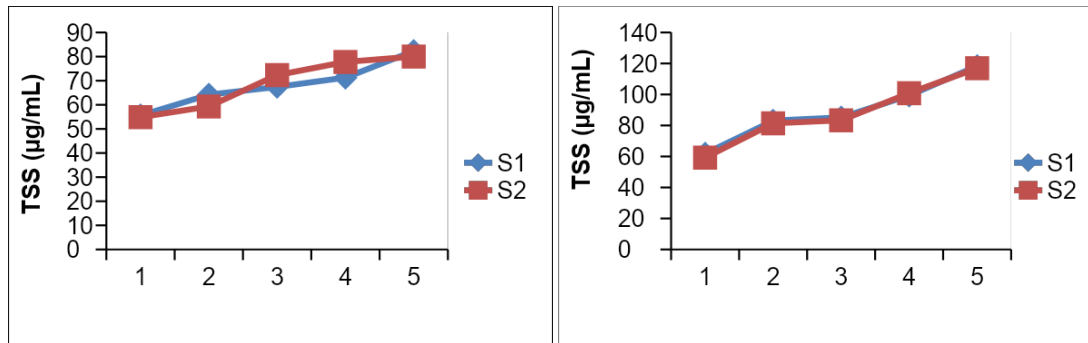
**Table: 3. The effect of post-harvest operations on the Mean Biochemical parameters of seed after processing in Soybean**

Factor	Level	Electrical conductivity ( $\mu\text{S cm}^{-1} \text{g}^{-1}$ )	Amino Acids in seed leachates ( $\mu\text{g/ml}$ )	Total soluble sugars in seed leachates ( $\mu\text{g/ml}$ )
Variety	Basara (V1)	194	26.48	68.51
	JS 335 (V2)	176	29.45	88.94
Post-harvest treatments	Manual threshing and Manual cleaning (P1)	216	27.84	57.89
	Mechanical threshing and Manual cleaning (P2)	180	27.07	71.99
	Mechanical threshing and Cleaning in Fine cleaner (P3)	176	28.12	77.07
	Mechanical threshing and Cleaning in Fine cleaner and grading in Spiral separator (using rubberized elevators) (P4)	171	28.05	87.28
	Mechanical threshing and Cleaning in Fine cleaner and grading in Spiral separator (using normal elevators) (P5)	184	28.75	99.39
Sieve size	3.75 mm (S1)	197	27.77	78.85
	4.00 mm (S2)	173	28.17	78.60
<b>CD</b>	Variety	NS	2.271	4.422
	Post-harvest treatments	NS	NS	6.992
	Sieve size	NS	NS	NS
	V X P	NS	NS	9.889
	V X S	NS	NS	NS
	P X S	NS	NS	NS
	V X S X P	NS	NS	NS

**Figure.3. The effect of various post-harvest operations and sieve sizes on Total soluble Sugars in Soybean**

**Total soluble sugars in seed leachates**

( $\mu\text{g/ml}$ )



**Post-harvest practices**

P1: Manual threshing and cleaning

P2: Mechanical threshing and Manual Cleaning

P3: Mechanical threshing and Cleaning in fine cleaner

P4: Mechanical threshing + Cleaning in fine cleaner+ grading in spiral separator (using rubberized elevators)

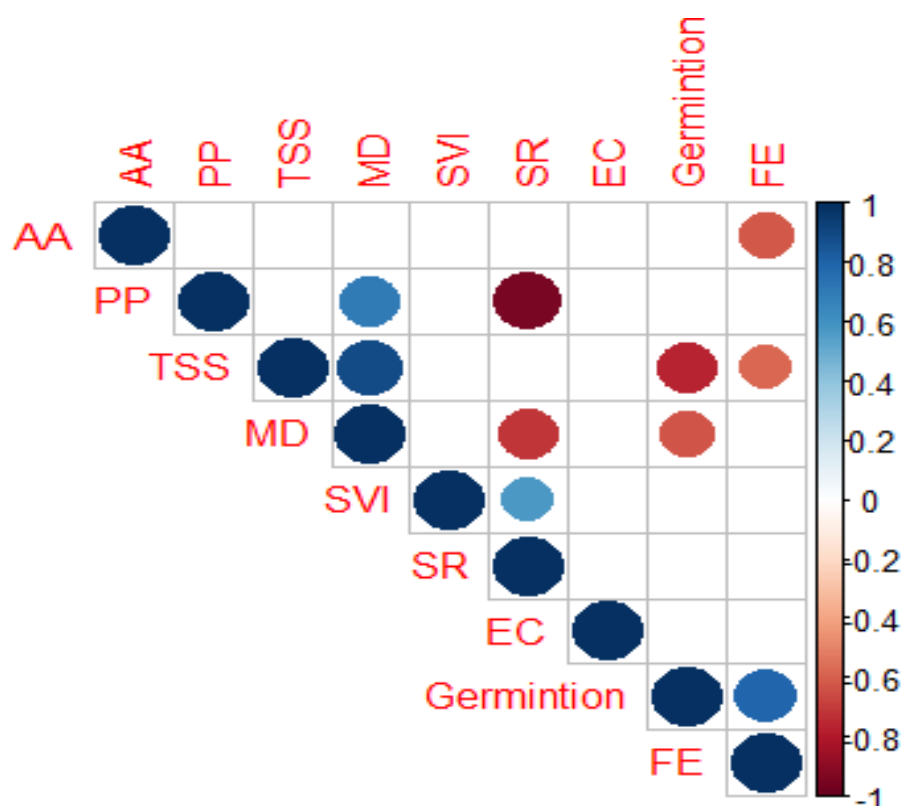
P5: Mechanical threshing + Cleaning in fine cleaner+ grading in spiral separator (using normal elevators)

**Sieve sizes**

S1: 3.75 mm

S2: 4.00 mm

**Figure:4. Correlation of seed quality characters of seed subjected to various post-harvest operations**



#### REFERENCES:

1. Abdul Baki, A.A and Anderson, J.D. (1973) Vigor determination in soybean seed by multiple criteria. *Crop Science*. 13: 630- 633.
2. Agrawal, R.L. 1995. Seed viability. *Seed Technology*. 2nd Edition: 580-582.
3. Bansal, N.K and Lahan, S.K. 2009. Design and development of an Axial flow thresher for seed crops. *Journal of agricultural engineering*. 46 (1): 1-8.
4. Cicero, S. M., G.W. A. M. Heijden, W. J. Van der Burg and R. J. Bino. 1998. Evaluation of mechanical damage in seeds of maize (*Zea mays* L.) by X-ray and digital imaging. *Seed Science and Technology*. 26: 603–612.
5. Delouche, James C. 2021. Maintaining Soybean Seed Quality. *Seed Technology Papers*. 101
6. Gagare, K.C., Bharud, R.W., Shelar, V.R and Karjule, A.P. 2014. Detection of mechanical

- damage to soybean seed surface using ferric chloride test. *Agriculture Science Digest*. 34 (4): 289-292.
7. Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R and Meybeck, A. 2011. *Global food losses and food waste* FAO Rome: 1-38.
  8. ISTA 2019. *International Rules for Seed Testing*. Proceedings of International Rules for Seed Testing Association. <https://doi.org/10.15258/istarules.2019.F>
  9. Karagi, C.D., Kati, S., Miki, A., Vujakovi, M., Millic, D., Vasiljevi, S and Milosevi, B. (2010). Effects of genotype and mechanical damage during harvest on field pea (*Pisium sativum* L.) seed quality. *Genetika*. 42 (3): 425 -434.
  10. Nagawade, D.R., Bharud, R.W and Shelar, V.R. 2015. Impact of processing on seed quality of soybean during storage. *BIOINFOLET-A Quarterly Journal of Life Sciences*. 12 (1b): 168-172.
  11. Navratil, R. J and J. S. Burris. 1984. The effect of drying temperature on corn seed quality. *Canadian Journal of Plant Science*. 64: 487–496.
  12. Panse, V.G and Sukhatme, P.V. (1978) *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research Publication. 87-89.
  13. Pascal, E.H and M.A. Ellis. 1978. Variation in seed quality characteristics of tropical grown soybeans. *Crop Science*. 18: 837-840.
  14. Rodrigo Albaneze., Francisco Amaral Villela., Jean Carlo Possenti., Karina Guollo and Ivan Carlos Riedo. 2018. Mechanical damage caused by the use of grain carts for transport during soybean seed harvest. *Journal of Seed Science*. 40 (4): 422-427.
  15. Seema and Betageri, S.N., 2021. Influence of stages of harvesting and threshing methods on soybean [*Glycine max* (L.) Merrill]. *Seeds*. 34: 87-89.
  16. Sinha, J. P., Dhaliwal, J. S and Sinha, S. N. 2009. Effect of machine parameters on threshing quality for seed crop in chick pea. *Journal of Agricultural Engineering*. 46 (4): 11-16.
  17. Vishwanath, R.H., Gurumurthy, R and Manjunatha, M.V. 2019. Influence of Seed Processing and Storage on Seed Quality of Soybean Var. DSb-21. *International Journal of Current Microbiology and Applied Sciences*. 8 (1): 1684-1694.
  18. Dubois, M., Gilles, K., Hamilton, J.K., Rebers, P.A., Smith, F., 1951. A colorimetric method for the determination of sugars. *Nature*. 5 (4): 167-169.